

# S P E C I F I C A T I O N

## A SAFETY SWITCH

### FIELD AND BACKGROUND OF THE INVENTION

5       The present invention relates to an electric safety switch and more particularly to a pressure switch for electric motors of apparatus and vehicles stopping of which must be ensured under any condition, even in case of blocking of the switch itself.

10       Switches of this type are already known in the art: US Patent No. 5,304,753 for example depicts a safety press switch of the mentioned type.

      Said switch comprises a contact-holding slide which is slidable under the thrust of an activation button  
15       receiving current from a terminal which is always alive and transmits said current to the terminal of an electric motor or alternatively to the terminal of a braking device. More specifically, when the button is in a rest condition the slide powers the brake terminal while the  
20       motor terminal is disconnected, and the opposite occurs when the button is in a work condition. A counter-spring bucks displacement of the button keeping it normally in a rest condition. The slide consists of two parts electrically in contact with one another but susceptible  
25       of mechanical separation: the slide, during its stroke, opens the contact with the brake terminal and, on reaching its end of stroke, closes the contact with the motor.

      It may happen that repeated opening and closing  
30       cycles of the motor contact cause the switch to get blocked by welding between the contact point on the slide and the contact point on the terminal, due to the electric arc created between said points at each opening and closing movement of the contact.

35       Without an appropriate safety device, this drawback, since the motor is maintained always powered, constitutes

a great risk for the safety of the operator assigned to the machine or for the vehicle driver and also for the safety of the apparatus itself.

In the switch of the described type safety consists  
5 in that, in case of welding between the contact points of the motor contact, when pressure on the activation button is released, the two slide parts separate under the thrust of the counter-spring, thereby breaking the electric contact between the portion welded to the motor  
10 terminal and the portion always alive. The slide portion coming back to the rest position restores the electric contact with the brake terminal and blocks the kinematic motion of all movable parts, preventing any reuse of the switch.

15 In a different type of switch the circuit for powering the motor terminal contemplates two contact points placed on either side of the slide and disposed at a mutual distance along the stroke of the slide: the slide during its stroke first closes a first contact on  
20 which no sparking occurs because the motor terminal is still disconnected, and subsequently closes a second contact of true connection with the motor. In case of welding between the contacts, said welding only takes place on the second contact: on occurrence of said  
25 welding the slide, during its return stroke, tilts relative to its normal movement axis because it is retained on the side where the second welded contact is present and free on the opposite side where the first contact is present, which first contact opens without  
30 difficulty interrupting power supply to the motor. However, this inclination of the slide causes blocking of the kinematic motion of the movable parts making the switch unusable.

35 All these switches have serious limits and drawbacks.

A first drawback arises from the fact that this type

of safety asks for a very long stroke of the activation button and the slide and this constitutes an annoying dimensional bulkiness and a factor of mechanical weakness of the switch.

5       A different drawback resides in that this type of structure needs structurally weak components from an electric point of view as well, since the components must maintain reduced physical sizes in order not to have a switch which is too bulky and heavy.

10       Another drawback is due to the fact that these switches do not contemplate the presence of any protection device against a too prolonged continuous use of same. As a consequence, the switch that badly withstands overheating due to such a use, is often  
15 subjected to failure with or without occurrence of welding of the contact points on the terminals and it does not even protect the motor from the consequences of such a use, involving economic charges for servicing, repair and replacement of damaged parts in the apparatus.

20       Now the Applicant has become aware of the fact that the listed problems could be solved with a switch of a new type capable of simultaneously ensuring full safety, functional qualities, reliability and low cost. In particular, the Applicant has sensed that a solution  
25 could be found in a particular combination between the switch architecture, the position of the contacts and the features of the employed materials.

#### SUMMARY OF THE INVENTION

Accordingly, the invention relates to a safety  
30 switch, in particular for motor circuits of manufacturing machines and electric vehicles in which said contact-holding elements are mutually electrically connected through conductive elements that are movable with respect to one another by relative displacement of mating  
35 surfaces in mutual contact.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the invention will become more apparent from the detailed description of a preferred but not exclusive embodiment of a switch in accordance with the present invention. This  
5 description will be set out hereinafter with reference to the accompanying drawings, given by way of non limiting example, in which:

- Fig. 1 is a perspective front view, partly in section, of a switch in accordance with the invention in  
10 a passive position, seen from the left;

- Fig. 2 is a perspective front view of the switch in Fig. 1, in an active position, seen from the right;

- Fig. 3 is a front view from the left of the switch in Fig. 1 during the opening step in a condition of  
15 failure;

- Fig. 4 is a sectional view of the switch in Fig. 1 taken along a transverse line II-II in Fig. 1, after the opening step, in a condition of failure;

- Fig. 5 is a perspective front view from the left  
20 of the switch in Fig. 1 at the end of the opening step, after a failure;

- Fig. 6 is a perspective front view of the switch in Fig. 1 under normal working conditions.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

25 In its most general form, the safety switch of the invention comprises a casing 1 inside which it is housed an activation key 2, a pair of contact-holding elements, identified as first 10 and second 11 elements respectively, and a triad of electric terminals 6, 7, 9,  
30 identified as central 6, first 8 and second 9 terminals respectively, emerging from the floor of said casing 1 on both sides thereof; these contact-holding elements 10, 11 oscillate around the same oscillation axis O-O between two positions that will be identified as a passive  
35 position and an active position, respectively. Each contact-holding element 10, 11 is disposed in a tilting

manner around an end of a corresponding laminar support, identified as first 6 and second 8 supports respectively, and each of said positions is fixed by a corresponding position of said activation key 2 pivoting about a rotation axis R-R parallel to the oscillation axis O-O. The central terminal 6 of the triad 6, 7, 9 is in permanent electric contact with one of the contact-holding elements 10, 11, whereas the two other terminals, first 7 and second 9 terminals respectively, are each alternately separated from or in electric contact with the corresponding first and second contact-holding elements 10, 11 depending on the position of key 2; the contact-holding element 10, 11 closed on the corresponding terminal 7, 9 in a passive position is separated from the latter in an active position and vice versa. The contact-holding elements 10, 11 are electrically connected to each other through two conductive elements 17a, 18a each of which is associated with its corresponding contact-holding element and they are capable of being separated from each other by relative displacement of mating surfaces in mutual contact during normal use.

In more detail, the safety switch of the invention comprises an open casing 1 of insulating material, preferably a plastic material, inside which a T-shaped key 2 is housed in a manner known by itself, which key rotates in a longitudinal direction in either way around a transverse rotation axis R-R disposed in the "T" foot. Extending from the casing floor, within the casing 1 itself, there is a separation baffle 5, radially projecting outwardly and dividing said casing into two longitudinal cavities identified as first and second cavities respectively; in the following the elements belonging to one of the cavities will be also identified with the adjective (first and second) relating to the corresponding cavity.

In the present description the term "longitudinal direction" means the rotation direction of key 2, "transverse direction" means the direction of axis R-R around which rotation of key 2 takes place, "radial direction" the one perpendicular to the plane containing  
5 said longitudinal and transverse directions.

Casing 1 is preferably provided on its outer side surface, with devices 100 enabling easy mounting of the casing itself, by forced fitting for example, in the  
10 apparatus for which it is intended. Key 2 comprises a surface turned towards the outside of casing 1 which is laterally provided with two opposite arms 3 and 4 radially extending inwardly of the casing, one for each cavity, and substantially embodying the "T" leg.

15 A triad of electric terminals is inserted in the floor of casing 1 for connection with the circuits to be controlled; preferably said triad comprises three plate-like lugs 6, 7, 9 of electrically conductive material projecting from said floor and facing said key 2. Also  
20 projecting from the floor is a further plate-like lug 8 preferably of insulating material, and also facing said key.

The first and third plate-like lugs 6 and 7 are inserted in the first cavity of the casing, the second  
25 and fourth plate-like lugs 8 and 9 are inserted in the second cavity disposed in side by side relationship with the first cavity; preferably, the first plate-like lug 6 and second plate-like lug 8 are in alignment with each other in a transverse direction and lie in the plane  
30 containing the rotation axis R-R.

Preferably, at least the plate-like lugs 6, 7 and 8 project from the floor of casing 1 also outwardly.

The plate-like lugs 6 and 8 constitute the laminar support for a pair of contact-holding elements 10, 11;  
35 more preferably, each end of the plate-like lugs 6 and 8 projecting inwardly of the container acts as a fulcrum.

for a corresponding contact-holding element 10, 11 oscillating around said fulcrum along a transverse oscillation axis O-O parallel to axis R-R.

Preferably each contact-holding element 10, 11  
5 comprises a pilot member 10c, 11c having a U-shaped conformation the base of which rests on the corresponding fulcrum and at least one of the sides of which is provided with a flange 10a, 11a on the free end thereof, said flange projecting in cantilevered fashion from said  
10 end and extending lengthwise, away from the oscillation axis. Fastened to this flange is an electric contact point 10b, 11b preferably consisting of a droplet of appropriate conductive material welded to the surface of said flange.

15 In more detail, contact point 10b is fastened to the flange surface 10a facing the floor, contact point 11b is fastened to the flange surface 11a facing the key 2.

The plate-like lugs 7 and 9 project inwardly of the casing at flanges 10a and 11a, respectively: preferably,  
20 the free end of each plate-like lug is provided with a flange 7a, 9a projecting in cantilevered fashion from said end and extended in a longitudinal direction towards the oscillation axis O-O. Fastened to each flange 7a, 9a is an electric contact point preferably consisting of a  
25 droplet 7b, 9b of appropriate conductive material welded to the flange surface. In more detail, contact point 7b is fastened to the surface of flange 7a facing key 2, contact point 9b is fastened to the surface of flange 9a facing the floor. The radial extension (height) of said  
30 plate-like lugs 7 and 9 is different; the plate-like lug 7 has flange 7a disposed between the flange 10a and the casing floor, the plate-like lug 9 has flange 9a disposed between flange 11a and key 2. In this way the contact points 10b and 7b, 11b and 9b always face each other in  
35 mutual correspondence.

Resting on the surface of the "U" base, i.e. the

contact-holding pilot member 10c, 11c facing key 2, is the end of a helical spring 12, 13 the opposite end of which is fitted on the end of an arm 3, 4 of key 2, in abutment against a locking relief. Preferably, the end of  
5 spring 12, 13 resting on the base of the pilot member 10c, 11c is maintained in place by a relief 14 in the form of a spherical cap radially projecting outwardly from said base.

The length of springs 12 and 13 is slightly greater  
10 than the distance between the abutment of arm 3, 4 and the base of the pilot member 10c, 11c, so that the springs are compressed and in an unstable equilibrium thereby taking a curvilinear trajectory; the resulting thrust exerted by each spring 12, 13 onto the  
15 corresponding pilot member 10c, 11c forces the pilot member itself to a predetermined position relative to the longitudinal direction.

In the longitudinal axial plane of key 2, linked to the radially internal surface of the key, there is a  
20 third arm 15 extending radially inwardly; the free end of this arm 15 is introduced into a third helical spring 16, in abutment against a locking relief, which spring has its opposite end housed within a cylindrical seat 16a protruding radially outwardly from the floor of casing 1.  
25 This seat keeps spring 16 working in compression in a substantially rectilinear configuration. Spring 16 which is compressed when key 2 is in its active position, supplies the required energy to overcome the resistance of springs 12 and 13 when the key is to be brought back  
30 to its passive position.

In accordance with the invention, the two pilot members 10c, 11c are electrically connected to one another through conductive elements 17, 18 movable with respect to one another by the relative displacement of  
35 mating surfaces 17a, 18a in mutual contact relationship.

In a preferred embodiment of the invention, the base



of each pilot member 10c, 11c is integral with an L-shaped plate 17, 18 respectively, radially extending outwardly (Fig. 4): more preferably the long leg 17, 18 of the "L" is fastened to the base of the pilot member 10c, 11c along the edge facing the adjacent pilot member, the short leg 17a, 18a of the "L" hereinafter referred to as "slide" projects in cantilevered fashion in a transverse direction from the free end of the long leg and faces the adjacent pilot member 10c, 11c as well. The two slides are preferably formed with a curvilinear or dihedral surface the concavity of which is turned towards the oscillation axis O-O, preferably with the dihedral edge parallel to said oscillation axis. The shapes of the two surfaces match one another and are in mutual forced contact, the slide 17a of the pilot member 10c being radially superposed on the slide 18a of the pilot member 11c.

The pilot member 11c is supported over the whole width thereof, in a transverse direction, by the second plate-like lug 8, whereas the pilot member 10c is supported in the same transverse direction over only half its width from the plate-like lug 6 which on its center line is provided with a step facing the pilot member 11c.

In conclusion, the pilot member 10c is respectively supported, at two transversely opposite positions, by the portion of the plate-like lug 6 constituting the fulcrum of the pilot member and by the slide 17a resting on the adjacent slide 18a.

The dividing baffle 5 has a recess extending radially outwardly at the position taken by the pilot members 10c, 11c when the switch is in its passive position.

The plate-like lugs 6, 7 and 9, as previously said, preferably project to the outside of casing 1 emerging from the floor of the casing itself: these projecting portions, in use, are connected to corresponding lead-in

wires of the conductors of the electric installation to be controlled; more specifically, the plate-like lug 6 belonging to the central terminal is connected to the supply voltage and is always energized, the plate-like  
5 lug 7 belonging to the first terminal is connected to a braking device of the apparatus, the plate-like lug 9 belonging to the second terminal is connected to the motor device of the apparatus. It should be pointed out that the laminar support 8 of the second pilot member 11  
10 is not directly connected with the electric circuit controlled by the switch; the material of the plate-like lug 8 can therefore be any suitable material, not necessarily an electrically conductive material. Still to be pointed out is the fact that the electric connection  
15 between the two pilot members 10 and 11 is made by the conductive elements 17 and 18.

Fig. 1 shows the switch of the invention in a first position herein defined as passive position. In this position the flanges 10a, 11a of the pilot members 10c,  
20 11c are inclined to the floor of casing 1: the contact between the pilot member 10c and the plate-like lug 7 is closed, the contact between the pilot member 11c and the plate-like lug 9 is open.

A pressure exercised on the radially external  
25 surface of key 2, alternately in the two end positions, rotates the key around the transverse rotation axis R-R substantially passing by the two side arms 3, 4 of key 2, close to the end of the corresponding springs 12, 12.

Said rotation of key 2 changes the inclination of  
30 arms 3, 4 and therefore reverses bending of springs 12, 13, fitted between the arm and the pilot member 10c, 11c, towards the longitudinally opposite direction: consequently, each spring 12, 13 forces the corresponding pilot member 10c, 11c to longitudinally swing on its  
35 fulcrum, causing inclination of flange 10a, 11a towards key 2. By effect of this change of inclination the switch

takes a position identified as active position, opening the contact between the pilot member 10c and the plate-like lug 7, while closing that between the pilot member 11c and the plate-like lug 9.

5        Operation of the switch takes place as follows. It is assumed that the switch must control an electric circuit, not shown, containing a motor device and a braking device, to be operated separately, through the plate-like lug 7 powering the braking circuit and the  
10 plate-like lug 9 powering the motor circuit, and it is also assumed that the switch is in a passive position, i.e. is powering the braking circuit. The plate-like lug 6 is connected with the mains voltage energizing the pilot member 10c as well. The braking system is powered  
15 by the plate-like lug 7 in electric connection with the pilot member 10c through the pair of contact points 10b and 7b. The pilot member 11c is energized as well, through the pair of slides 17a and 18a, but the flange 11a and plate-like lug 9 are separated and therefore the  
20 motor circuit is not powered.

The motor circuit is now required to be powered: by exerting pressure on the end of key 2 which is raised with respect to casing 1, rotation of the key is caused and, with this rotation, oscillation of each pilot member  
25 10c, 11c around the respective fulcrum occurs.

This oscillation reverses the inclination of the pilot members 10c, 11c relative to the oscillation axis O-O: the contact points 10b and 7b are separated so that the braking circuit is no longer energized and the  
30 contact points 11b and 9b are brought into mutual contact and the motor circuit is powered.

It is now assumed that for any accidental reason, due for example to sparking caused by the repeated opening and closing movements, contacts 11b and 9b remain  
35 welded to one another thereby blocking the pilot member 11c in the condition at which powering of the motor

circuit occurs.

In this case, pressure exerted on the rear portion of key 2 (Fig. 3) will succeed in causing oscillation of the pilot member 10c alone, bringing contacts 10b and 7b  
5 to the position of mutual contact that will result in power supply being restored to the braking circuit, at the end of the oscillation.

Following this oscillation of the pilot member 10c the corresponding slide 17a smoothly moves along the  
10 radially external surface of the underlying slide 18a until the mutual contact is lost. In this way, however, slide 17a loses its support and consequently the pilot member 10c only supported close to the outer centre line of its base and submitted to the pressure of spring 12,  
15 falls (Figs. 4 and 5) towards the dividing baffle 5 while the slide 17a is positioned within the recess of said baffle.

Contact loss between the two slides 17a, 18a de-energizes the pilot member 1 and therefore the motor  
20 circuit is no longer powered.

It will be understood that now the safety switch is blocked: in fact, a pressure on the front portion of key 2 does not succeed in producing the reverse oscillation of the pilot member 10c because the recess of the  
25 dividing baffle 5 blocks the slide 17a inside it, inhibiting any further movement.

Insertion of slide 17a in the recess of baffle 5 prevents said slide from accidentally coming into contact with slide 18a, due to movements or vibrations of the  
30 apparatus on which the switch is mounted, for example.

For restoring operation of the apparatus, replacement of the blocked switch with a new switch is inevitably required.

However, the low cost of the switch makes repair of  
35 same economically unsuitable.

Taking now into account the plate-like lug 8, it has

been already seen that it can be made of a non conductive material too. Preferably, in accordance with the invention, the plate-like lug 8 is made of a plastic material having a low melting point.

5        This invention enables accomplishment of another safety device associated with the just described switch. Operation of the motor in a continuous manner above all with the maximum current absorption, may cause overheating of the motor and/or the elements associated  
10 therewith with possible occurrence of drawbacks and damages. An equipment failure too (short-circuit) gives rise to a current absorption of much higher intensity than the maximum intensity allowed thereby jeopardizing safety of the associated devices.

15        The invention remedies these problems by making the plate-like lug 8 of fusible material. In fact, overheating due to a failure or to an improper use also concerns the pilot members 10c, 11c the temperature of which is increased during operation. This temperature  
20 increase does not affect the plate-like lug 6, which is made of metal as well, but can lead the plate-like lug 8 to fusion. As a consequence of this fusion, the pilot member 11c falls on the floor of casing 1 losing its contact with the flange 9 and therefore losing its  
25 possibility of oscillating. Subsequent pressures of key 2 can only cause smooth moving of the pilot member 11c along the floor of the second cavity but cannot restore the lost electric connection.

      A person skilled in the art will be able to  
30 conveniently select the sizes, in particular thickness, of the pilot member 11 and of the plate-like lug 8, together with the type of the material to be used, in order to regulate the time and temperature values causing fusion of the plate-like lug 8.

35        The invention has many important advantages.

      A long directional stroke of the actuating key is

not required for the switch; the key rotates about an axis remaining fixed relative to the casing body so that the key stroke is limited to the lifting amount of the key ends relative to the casing surface, following said  
5 rotation. Therefore the switch on the whole is of reduced sizes, more compact and more solid. This in spite of the fact that the movable and fixed elements of the electrically conductive portion are bigger than the corresponding elements in the known art; in particular,  
10 the contact points have larger sizes and are made of a material suitable for the purpose, so that they withstand values of current intensity much higher than the switches normally used in this type of service. These features minimize the possibility of failures for the switch of  
15 the invention and prolong duration of same.

In case of failure, both voltage maintenance on a specific lead-in wire and absence of voltage on a different specific lead-in wire is ensured; this electric configuration keeps unchanged even in case of shakes,  
20 vibrations and other movements produced on the switch.

Ultimately, the switch of the invention mostly comprises mechanical elements already used in the known art for large-use switches and therefore it is cheaper than the safety switches already known, the above  
25 mentioned defects typical of the latter being also avoided.

In the present specification all possible structural and kinematic alternative forms to the specifically described embodiments of the invention have not been  
30 illustrated. All parts herein described as conductive parts can be made of a non-conductive material for example, and made conductive by deposition or insertion of tracks of conductive material in the body of said parts.

35 However all these variant forms are intended to be also included within the protection scope of the present

invention, as they can be easily envisaged from the description herein made of the relationship existing between each embodiment and the result that the invention wishes to achieve.,

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